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# OPERATION OF TRAINS ON HEAVY GRAD

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## REPORT OF SAFETY APPLIANCE INSPECTORS

TO

U. S. THE INTERSTATE COMMERCE  
COMMISSION

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INTERSTATE COMMERCE COMMISSION  
WASHINGTON, D. C.  
DECEMBER, 1907

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## OPERATION OF TRAINS ON HEAVY GRADES

WASHINGTON, D. C., *December 4, 1*

DEAR SIR: We have completed our investigation concerning practice of handling trains on heavy grades, which you instructed us to make, and desire to report as follows:

In order that our investigation might cover the most severe conditions, we visited no grades of less than 75 feet to the mile and no grades on standard railroads which do a heavy tonnage business.

We were accompanied by Mr. J. R. Alexander, general roadmaster of engines of the Pennsylvania Railroad, and every company was extended us by the different lines visited, with the exception of the Baltimore & Ohio Railroad, which company refused permission to ride on its freight trains except on Sand Patch grade. On many railroads we were accompanied by their air-brake inspectors, train masters, or road foremen of engines, who assisted in the investigation.

We submit for your consideration a statement showing the general condition of air brakes on each line visited and the practice followed in their use.

### NORTHERN PACIFIC RAILROAD.

The Northern Pacific Railroad has four heavy mountain grades between Livingston, Mont., and Seattle, Wash.

Livingston Mountain is a grade of 116 feet to the mile for 11 miles. Trains of from 1,400 to 1,600 tons weight, and 35 cars in length are handled on this grade. No examination of air brakes is made at the top of this grade except by train crews. Inspections are supposed to be made at Bozeman for east bound, and at Livingston for west bound trains. The general practice is to control trains entirely by air brakes, but from observation, and information furnished by train crews, we found that hand brakes are sometimes used.

Helena Mountain is a grade 19 miles in length, the last portion being the lighter portion. This grade is about 116 feet to the mile and trains of from 1,600 to 1,800 tons weight and 35 to 40 cars are handled. No examination of air brakes is made at the

mountain except by train crews. At the top of this grade there is a tunnel about 1 mile in length. The general practice is to control trains by the use of air assisted by hand brakes. No train we inspected went down this grade with air alone. Hand brakes were used on each train.

Missoula Mountain is a grade of about 8 miles on the west side and 7 miles on the east side. This grade is about 116 feet to the mile, and trains of from 1,600 to 1,800 tons weight and 35 to 42 cars long are handled. No examination of air brakes is made at the top of this grade except by train crews. The general practice is to control trains entirely by air brakes, and all trains inspected by us were so controlled, yet train crews informed us that they sometimes resort to the use of hand brakes.

Cascade Mountain is a grade of about 116 feet to the mile, extending for about 8 miles on both the east and west sides of the mountain. Trains are of from 1,000 to 1,500 tons weight and 25 to 35 cars long. No examination of air brakes is made at the top of this grade except by the train crews. The general practice is to control trains entirely by air brakes, but from observation and information furnished by train crews we found that hand brakes are sometimes used.

The condition of air-brake equipment on this road is fairly good. On 25 trains we noticed 49 cars with the air brakes cut out and not in use.

The instructions to train crews governing all the grades are: "Before commencing descent of mountain grades test of brakes will be made. Conductor and engineer conferring and deciding as to sufficiency of air and additional use of hand brakes necessary. Other use of hand brakes will not be made unless engineer calls for assistance or fails to properly control train, in which event immediate and full use of hand brakes will be made." Our observation indicated that these instructions are obeyed.

In the trains inspected by us the average weight was 42 tons per brake and by thermal tests made to determine the efficiency of the air brakes, the tonnage per brake was 53 tons.

#### GREAT NORTHERN RAILROAD.

The Great Northern Railroad has several heavy grades, only two of which we visited.

Butte Mountain grade is about 12 miles in length and 116 feet to the mile. Trains are from 1,200 to 1,800 tons weight and 30 to 40 cars long. The freight handled is principally ore, the cars used being assigned to this service and the majority of them used exclusively over this mountain. The general practice is to control trains entirely by air brakes. The air equipment is tested at Woodville and Great Falls, and no special examination is made at the top of

the mountain. The tonnage handled down this grade was 58 tons per brake and no hand brakes were used.

Cascade Mountain is a grade of 21 miles on the west side of the mountain and 11 miles on the east side. This grade is 116 feet to the mile, with a tunnel over 2 miles long at the top. Trains of from 35 to 45 cars long and from 1,000 to 1,500 tons weight are handled. No loaded train is handled without using hand brakes.

Of the five trains inspected on the Great Northern Railroad we found 12 air cars cut out and not in use, all on Cascade Mountain.

#### SOUTHERN PACIFIC RAILROAD.

The Southern Pacific Railroad has several heavy mountain grades, ranging from 116 to 175 feet to the mile.

Siskiyou Mountain is a grade of about 18 miles on each side of the Siskiyou Mountain Range, and is about 174 feet to the mile. Trains of from 20 to 35 cars are handled over this mountain and run from 900 to 1,200 tons weight. The general practice is to control trains entirely by air brakes. Speed of trains does not exceed 12 miles per hour. No train is handled over this mountain with an average tonnage exceeding 40 tons per brake. Cars are inspected and all piston travel adjusted at Dunsmuir and Ashland.

Shasta Mountain is a grade of 9 miles and about 116 feet to the mile. Trains that do not exceed 35 cars and a tonnage of about 1,000 to 1,400 tons are handled, and must not exceed a speed of 15 miles per hour. The general practice is to control trains entirely by air brakes.

The Sierra Nevada Mountain grade is over 70 miles in length and ranges from 90 to 130 feet per mile. Trains are limited to 35 cars. No train can exceed an average of 40 tons per brake. Speed is limited to 10 miles per hour for slow and 15 miles per hour for fast freight. Trains are controlled entirely by air brakes, no hand brakes being used. All cars receive thorough inspection at Sacramento and Sparks, and at three points between those terminals inspectors are stationed.

Tehachapi Mountain is a grade of over 20 miles on the north side and 10 miles on the south side, and about 116 feet to the mile. Trains are limited to 40 cars and 50 tons per brake. Trains are from 1,000 to 1,500 tons weight. The general practice is to control trains entirely by air brakes.

The air-brake conditions on the Southern Pacific are exceptionally good. Of the 12 trains inspected on four mountain grades no hand brakes were used and only 5 cars were found with brakes cut out and not in use. The average tonnage per brake in train on the 12 trains inspected was 34 tons and, as per the thermal tests made to determine the efficiency of the air brakes, the average tonnage per brake was 38.



## DENVER &amp; RIO GRANDE RAILROAD.

The Denver & Rio Grande Railroad has several heavy grades, but we visited only the ones where heavy tonnage is handled on standard-gauge lines.

Bingham Mountain has two grades, one 9 miles long, ranging from 100 to 211 feet per mile, the other 14 miles long and 116 feet to the mile. On the shorter and heavier grade hand brakes are used on all cars, and on the longer grade hand brakes are used on only a portion of the train. The tonnage is ore, and very heavy. On the 14-mile grade trains of 30 cars of about 1,800 tons weight are handled; on the 9-mile grade trains not to exceed 600 tons weight are handled. All air cars are inspected and piston travel adjusted before descending either grade.

Soldier Summit is a grade 7 miles long on the heavy side and about 211 feet to the mile. On the opposite side of the mountain the grade is from 100 to 130 feet per mile, and from Tucker to Thistle, 18 miles, is from 80 to 130 feet to the mile. Trains are controlled entirely by air brakes, except on the Soldier Summit grade, where hand brakes are used. On this grade trains are from 650 to 850 tons weight, and on all trains hand brakes are used in connection with the air brakes.

Sunny Side grade is 10 miles long and ranges from 116 to 158 feet per mile. Trains of 32 cars and about 1,800 tons are handled. The general practice is to set a few hand brakes.

Tennessee Pass is a grade 21 miles long and about 158 feet to the mile. The trains handled do not exceed 800 tons in weight and hand brakes are used on all trains unless they are very light.

Air brakes on the Denver & Rio Grande Railroad are kept in good condition. Cars are given good attention at the tops of grades, where special men are kept to look after air brakes.

On the 12 trains inspected on this road only 4 cars were found with air brakes cut out and not in use.

## COLORADO MIDLAND RAILROAD.

On the Colorado Midland Railroad we visited the Continental Divide. This grade on one side is 171 feet to the mile for 8 miles and on the other side is 158 feet to the mile for 30 miles. Tonnage is less than 800 tons per train. The general practice is to set hand brakes if train is very heavy. Trains are sometimes controlled entirely by air brakes.

On Ute Pass near Colorado Springs the grade is 211 feet per mile for 4½ miles and 158 feet for 5 miles. Trains of light tonnage are handled with air alone, but on trains of heavy tonnage the crews say that they set hand brakes.

Air-brake conditions on the Colorado Midland Railroad are good. On the three trains inspected only one car was found with brakes cut out and not in use.

#### ATCHISON, TOPEKA & SANTA FE RAILWAY.

On the Atchison, Topeka & Santa Fe Railway we visited three mountain grades.

Tehachapi Mountain is a grade of over 20 miles on the north side and 10 miles on the south side and about 116 feet to the mile. Trains are limited to 40 cars and 50 tons per brake. Trains are from 1,000 to 1,500 tons weight. The general practice is to control trains by means of hand brakes, assisted by air brakes.

Glorietta Mountain grade is about 10 miles long and about 158 feet to the mile. No limit to cars or tonnage on this grade. Hand brakes are used on all trains.

Raton Mountain is about 13 miles long and about 184 feet for 5 miles and 116 feet for 8 miles on the north side of the mountain, and 7 miles long and 175 feet to the mile on the south side. Hand brakes are used on all trains on both sides. No men are employed at top of any mountain on the Atchison, Topeka & Santa Fe Railway to look after air brakes and no trains are run that do not have hand brakes set on them.

On 11 trains inspected we found 5 air-brake cars cut out and not in use.

It will be noted that the Southern Pacific Railroad is handling trains over Tehachapi Mountain with the air brake, while the Atchison, Topeka & Santa Fe Railway is resorting to the use of hand brakes on the same grade.

#### PENNSYLVANIA RAILROAD.

On the Pennsylvania Railroad we visited four mountain grades.

Bellwood grade is about 8 miles long and about 175 feet to the mile. Trains are about 30 cars long and usually run from 1,400 to 2,000 tons in weight. Trains are controlled entirely by hand brakes. Air brakes are used only when necessary. On this grade some cars are used with air brakes working opposite to hand brakes, and these cars are generally cut out so as not to throw men from train if air brakes are applied.

Tyrone grade is about 10 miles long and is about 130 to 158 feet to the mile. Trains of from 28 to 40 cars are handled, running from 1,600 to 2,000 tons weight. Trains are controlled by hand brakes. Air is used only to assist in case of necessity. On this grade cars are also used with air brakes working opposite to hand brakes.

Dunlo grade is  $4\frac{1}{2}$  miles long and from 158 to 200 feet to the mile. Only one train crew works on this grade, handling about 25 cars per

train of about 1,500 to 1,700 tons weight. Trains are handled with both air and hand brakes.

Gallitzen grade is 11 miles long and 123 feet per mile for first mile and 90 feet per mile for last 10 miles. Trains are from 20 to 40 cars long and about 1,500 to 2,000 tons weight. Extra heavy tonnage, principally coal and coke. Hand brakes are used on all trains to assist engineer, usually about 4 to 8 being set on head end of each train.

Air brakes receive good attention at top of grade, where 13 men are employed as inspectors.

Pottsville grade is 11 miles long, about  $4\frac{1}{2}$  miles being 165 feet to the mile and the remainder 63 feet to the mile. The trains handled are short trains of coal and coke.

The general practice is to control trains entirely by air brakes.

Of the 17 trains, containing 460 cars, inspected by us we found only 15 cars with air brakes cut out, of which 13 were cut out on account of air working opposite to hand brakes.

#### PHILADELPHIA & READING RAILWAY.

Frackville grade on the Philadelphia & Reading Railway is 6 miles long and about 185 feet to the mile. Trains are from 18 to 30 cars long and 1,000 to 1,500 tons in weight. Hand brakes used on all trains.

#### ERIE RAILROAD.

Gowanda grade is about 5 miles long and about 132 feet to the mile. Trains are from 25 to 30 cars long and 1,000 to 1,400 tons in weight. Hand brakes are used to control trains and air is only used when necessary.

Big Shanty grade is about  $6\frac{1}{2}$  miles long and about 129 feet for first mile, 105 feet for 3 miles, and about 55 feet for  $2\frac{1}{2}$  miles. Trains are coal trains of about 30 cars and about 1,600 to 1,700 tons each. Trains are controlled by hand brakes and air is used only when necessary.

#### BUFFALO, ROCHESTER & PITTSBURG RAILROAD.

Bingham grade is about 9 miles long and about 79 feet to the mile. Trains are 40 to 45 cars long and about 2,250 to 2,500 tons in weight. The general practice is to control trains by air brakes entirely.

West Valley Mountain grade is about 6 miles long and about 89 feet to the mile. Trains are from 35 to 40 cars long and 1,500 to 1,800 tons in weight are handled. The general practice is to control trains entirely by air brakes.

The air-brake conditions on the Buffalo, Rochester & Pittsburgh Railroad are good. We found 8 cars with air brakes cut out and not in use on 5 trains, but no hand brakes were used on these trains.

## DELAWARE, LACKAWANNA &amp; WESTERN RAILROAD.

Clark Summit grade is about  $7\frac{1}{2}$  miles long and about 78 feet to the mile. Trains of about 50 cars and about 2,000 to 2,300 tons are handled. Trains are handled with air brakes only.

Pocono Mountain is about 17 miles long and about 80 feet to the mile. Trains of from 30 to 40 cars long and 1,500 to 2,500 tons in weight are controlled by air brake entirely.

The air-brake conditions on the Delaware, Lackawanna & Western Railroad are good. Seven cars were found with air brakes cut out and not in use on the 4 trains we inspected, but no hand brakes were used on any of these trains.

## BALTIMORE &amp; OHIO RAILROAD.

Sand Patch grade is about 20 miles long and about 85 to 95 feet to the mile. Trains are 40 cars per train regardless of tonnage, which runs from 2,000 to 3,000 tons per train. Trainmen are required to use hand brakes to control all trains, and the rules of the company prohibit the use of air brakes except in emergency.

This was the only grade on Baltimore & Ohio Railroad that we visited, on account of the company's refusal to allow us permission to ride on freight trains on any other grades. No air inspection at top of Sand Patch grade. On the three trains inspected we found 15 cars with air brakes cut out and not in use.

## GENERAL OBSERVATIONS.

There is no comparison as to the density of traffic on the roads in the western country and those east of the Allegheny Mountains either in number of trains handled per day or in the number of tons handled per train or per brake. On western lines the usual run of freight trains is from 6 to 12 per day, while on the double-track lines of the Delaware, Lackawanna & Western Railroad, Pennsylvania Railroad, and Baltimore & Ohio Railroad there are handled from 60 to 100 trains per day.

The tonnage handled per brake on western roads is very much lighter than that on roads in the East. Of 68 trains west of Denver the average tonnage per brake was 38 tons, while on 35 trains east of the Allegheny Mountains the average tonnage per brake was 57 tons. While this tonnage is an average of all trains inspected, there were trains on the Pennsylvania Railroad that averaged 77 tons per brake.

The roads doing the best air-brake work to-day are those which maintain their equipment in the best condition. Special air-brake repair men are stationed on the Denver & Rio Grande Railroad at the top of Bingham Mountain, Tennessee Pass, and Soldier Summit, and special air inspection is made by air-brake inspectors at the top of Gallitzen and Pottsville grades on the Pennsylvania Railroad;

also, at the top of Pocono Mountain on the Delaware, Lackawann & Western Railroad. Other lines, like the Northern Pacific Railroad, Southern Pacific Railroad, Atchison, Topeka & Santa Fe Railway, Colorado Midland Railroad, and Buffalo, Rochester & Pittsburgh Railroad require train crews to make tests at top of mountains, but maintain no extra force of men to make repairs that may be necessary.

Where heavy tonnage is handled on steep grades the use of hand brakes to assist the engineer in controlling trains by air brakes, thus enabling him to maintain a higher air pressure, is justified as an additional factor of safety.

Two brakemen and a conductor are employed on trains on the Northern Pacific, Great Northern, Colorado Midland, Delaware, Lackawanna & Western, and Buffalo, Rochester & Pittsburgh railroads, and, also, on the Southern Pacific, except over Tehachapi Mountain, where three brakemen and a conductor are employed. On the Denver & Rio Grande two brakemen and a conductor are employed, except on Tennessee Pass, three brakemen and a conductor being there employed. On the Atchison, Topeka & Santa Fe two brakemen and a conductor are employed, except on Glorietta Mountain, where a conductor and three brakemen are employed on some trains. Three brakemen and a conductor are employed on all trains on the Pennsylvania Railroad, Erie Railroad, and Baltimore & Ohio Railroad.

From our conversation with employees with whom we came in contact during our investigation we found the men on railroads that do good air-brake service satisfied that the air brake will safely hold trains when not overloaded; while on railroads that are using hand brakes to any extent the employees say they would not attempt, under any circumstances, to take trains down grades with air alone.

We submit herewith a tabulated statement showing the trains inspected by us with respect to the following points:

1. Number of cars in train.
2. Gross tonnage in train.
3. Grade in feet per mile (obtained by record furnished and observation and is our best judgment as to what these different grades are).
4. Air-brake cars in operation.
5. Air-brake cars cut out and nonair-brake cars in train.
6. Tonnage per brake in train.
7. Tonnage per brake as per thermal test. (Thermal or wheel temperature test which is made for the purpose of ascertaining the efficiency of the air on each car. Cars arrived at foot of grade with hot wheels being considered good mountain brake, cars with wheels only warm being considered as one-half good mountain brake, and

cars with wheels cold as doing no mountain service. Thermal test not being considered accurate on trains on which hand brakes were used.)

8. Number of hand brakes set, if any.
9. Air pressure, both maximum and minimum, on grade.
10. Speed of train on grade, averaged.
11. Length of grade.

#### CONCLUSIONS.

The handling of heavy tonnage trains on heavy grades exclusively by air brakes will, of necessity, be governed by the following conditions, viz: Equipment, grade, and the method of operation and maintenance.

First. With respect to equipment, it is absolutely necessary that all cars be equipped with air-brake appliances, and that same be kept in first-class condition.

Second. The tonnage per brake that can be safely handled on heavy grades is a question that demands careful attention, and this, in connection with the grade conditions, will be the governing feature as to how successfully a train can be handled by air brakes alone.

Third. Operation and maintenance, which means the placing of equipment in first-class condition, in the hands of competent men fully instructed as to its use and familiar with the grade conditions on which they are working, so as to keep trains always under control and at a safe speed. We visited grades ranging from  $1\frac{1}{2}$  per cent, or 78 feet to the mile, to 4 per cent, or 211 feet to the mile, on standard roads doing a heavy tonnage business, and the tabulated statement submitted herewith shows the manner in which these trains were handled. Our observations along these lines, covering the different grades visited, lead us to believe that trains of an average tonnage of 35 tons per brake can be safely handled by air brakes alone on grades of 3 to 4 per cent, that trains of an average tonnage of 45 tons per brake can be so handled on grades of 2 to 3 per cent, and trains of an average tonnage of 50 tons per brake can be so handled on grades of  $1\frac{1}{2}$  to 2 per cent.

Respectfully, yours,

JAMES J. COUTTS,

H. W. BELNAP,

*Inspectors.*

HON. EDWARD A. MOSELEY,

*Secretary Interstate Commerce Commission,*

*Washington, D. C.*















